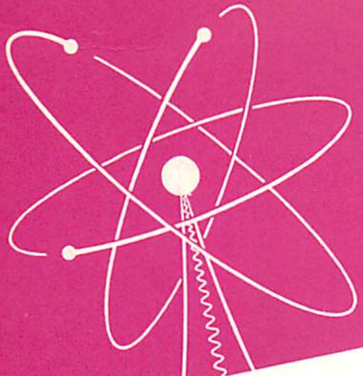

COLOR TV TEST EQUIPMENT

Lesson T4E-12A

DeVRY Technical Institute
4141 W. Belmont Ave., Chicago 41, Illinois
Formerly DeFOREST'S TRAINING, INC.

T4E-12A

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Chicago 41, Illinois

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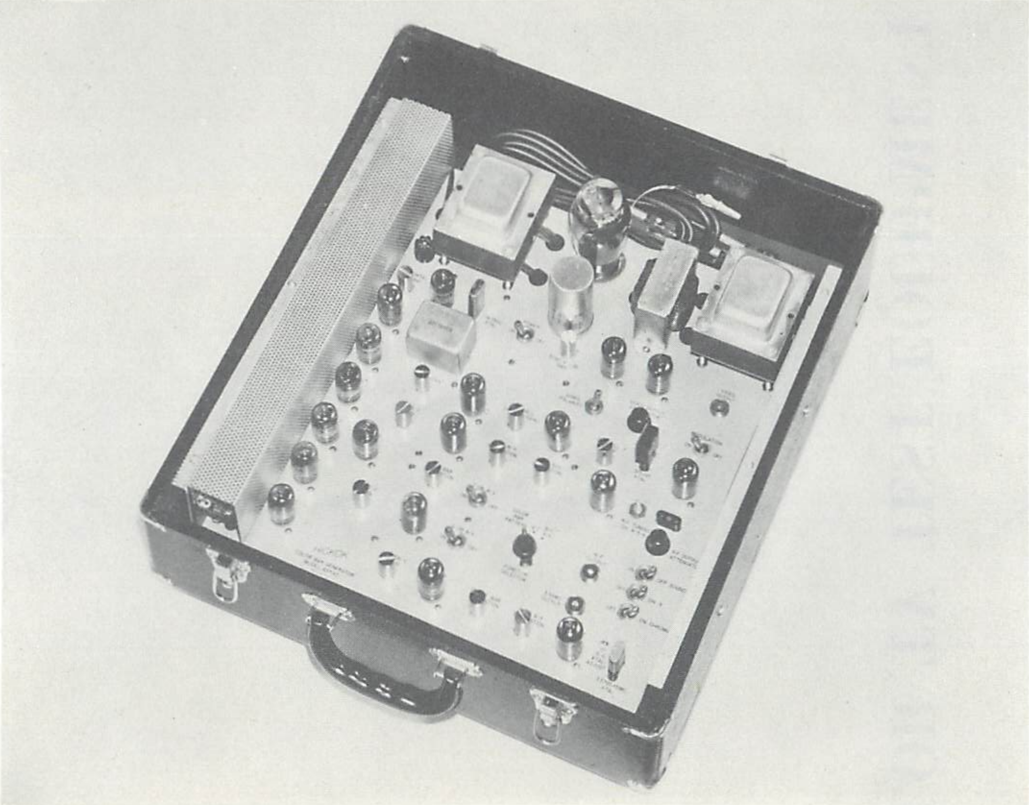


The Hickok color-bar generator produces a standard NTSC signal with provisions for obtaining a variety of color-bar patterns.

Courtesy Hickok Electrical Instrument Company

COLOR TV TEST EQUIPMENT

Contents

PAGE

Dot-Bar Generators 5

  Sylvania Dot Generator 6

  RCA WR-36A Dot-Bar Generator 9

Color Bar Generators 13

  RCA Color Bar Generator 15

  Hickok Color Bar Generator 18

Oscilloscopes 18

  Jackson CRO-2 Scope 20

Alignment Generators 24

Video Sweep Generators 25

Probes 26

Other Equipment 28

Television commands 100% active attention from its audience, as against a given percentage of passive attention received by many other media. Out of a given potential audience, television will often obtain a higher actual audience than sound programs because television, having sight, sound, motion and immediacy, has more appeal than sound alone. In addition, there are fewer simultaneous television programs on the air to split the audience.

—Electronics

COLOR TV TEST EQUIPMENT

Up to this point in our series of lessons on color television, emphasis has been placed on theory of operation of the many circuits and components that are found in a color television receiver. In this lesson and several lessons to follow, the installation, servicing, and alignment of the receivers will be stressed along with explanations of circuit operation where necessary. Naturally, where service work is concerned, one of the most important duties of the serviceman is to understand the operational characteristics and uses of the test equipment already being used to service monochrome TV receivers and to become familiar with additional test equipment needed for the servicing of color TV receivers.

Due to the complexity of the circuits in a color TV receiver, the requirements of familiar equipment is more exacting and new equipment which is unfamiliar to the serviceman has been created to facilitate the servicing of the color TV receiver.

Two of the most useful pieces of new test equipment are the dot generator and the **color-bar generator.** When the receiver employs a three-gun shadow-mask type of picture tube (as most of the present-day receivers do), a dot generator is necessary for making the convergence adjustments and the color balance or black and white adjustments. It is also useful in making size and linearity adjustments on both color and monochrome receivers.

The color-bar generator is very useful for installing, servicing and aligning color TV receivers. When a receiver is installed there may be some difficulty in obtaining a color picture and the color-bar generator is used to determine if the receiver or the antenna system is at fault. The initial adjustments are best performed when a steady state signal, such as a bar pattern, is being observed on the screen.

A third piece of test equipment which is not commonly found in the average TV service shop is the video sweep generator. Alignment of the video amplifiers, the band-pass or chrominance amplifier and the circuits immediately following the color demodulators is very important if proper colors are to be reproduced. For these circuits a video sweep generator with an output flat from about 50 kilocycles to about 5 megacycles is necessary. Provisions also must be provided for obtaining an accurate source of markers at video frequencies to adjust the various traps.

In addition to the new equipment required, color television has made it necessary for the more familiar equipment to be of higher quality. As has been mentioned in previous lessons, the frequency response of the r-f and i-f amplifiers is considerably more critical than it is in black-and-white receivers as the overall frequency response must allow the complete chrominance signal and the color burst to be amplified without any serious attenuations or phase shift. Accordingly, it becomes necessary to use a sweep generator that has an output flat over the desired band of frequencies, and a marker generator that employes crystals or provides marker signals having the accuracy of crystal control.

Since it is necessary to observe wave-forms in the 3.58 mc color circuits, the oscilloscope used for this purpose must be the wide-band type with the frequency response of the vertical amplifiers being flat to approximately 4.5 mc and it must have sufficient gain to reproduce low amplitude signals.

Even the high voltage circuits in a color TV receiver are more critical than those used in a monochrome receiver and it is usually necessary to make measurements and adjustments of the high voltage using a probe that is capable of giving very accurate readings.

For these reasons, the purpose of this lesson is to describe the new equipment that is needed for color TV servicing and alignment, along with emphasizing the increased requirements that are placed on the more familiar equipment.

The Dot-Bar generator is rapidly becoming a necessity for the color TV technician to permit convergence adjustments to be made rapidly and accurately.

Courtesy Radio Corporation of America

DOT-BAR GENERATORS

Probably the most often needed piece of new test equipment that the serviceman will use is the **dot or dot-bar generator.** Due to the difficulty encountered in attempting to make convergence adjustments while observing a regular television picture, it is not practical to attempt these adjustments unless a stationary pattern is being observed. It has been found by experiment that a white dot pattern on a dark background will enable the technician to analyze the misconvergence and determine what adjustments are needed. The use of a dot pattern also lends itself to a definite procedure for obtaining the best convergence in the least amount of time.

The dot generator should produce a signal so that the individual dots in a misconverged dot trio will be in the primary colors. Also, the dots should be large enough to be seen easily but not so large that the convergence adjustments are not accurate.

Although not absolutely necessary, a desirable feature of the dot generator is a means of providing an r-f output signal on several channels. This will enable the serviceman to select a channel which is not being used by a local TV station and prevent interference from such a source. Both positive and negative polarity video signals may also be useful as the signal can then be fed to the grid of the first video amplifier and the polarity switch set to give white dots. This selection will depend upon the design of the video amplifier section of the receiver.

Another desirable feature is a provision for horizontal and vertical bars or a **crosshatch pattern** which is a combination of vertical and horizontal bars. The linearity and size controls in the sweep circuits of the color receiver can be adjusted quite accurately by observing the patterns provided by the generator.

If the generator provides an r-f signal output, it is not necessary to maintain a high degree of accuracy as it produces only white dots or white bars. Any color in the picture is due to misadjustment of the convergence controls in the receiver.

Sylvania Dot Generator

The Sylvania dot generator is designed to produce a white dot pattern of about 16 horizontal and 12 vertical rows of dots. The actual number of dots produced in each direction can be varied slightly by adjustment of the horizontal and vertical sync controls located in the front panel. The output of the generator is applied directly to the three grids of the three-gun color kinescope by means of a special adapter which connects between the base of the picture tube and the socket of the picture tube.

A block diagram of the dot generator circuit is shown in Figure 1. Fundamentally, the overall function of the generator is quite simple in that the pulses from the two multivibrators are added together and amplified to produce positive pulses at the output of the generator which are then applied to the grids of the picture tube.

To be more specific, in the corresponding schematic diagram of Figure 2, negative vertical sync pulses from the receiver are applied to the integrator network of R_{101}, C_{102} and R_{102} to prevent the horizontal pulses from triggering the vertical oscillator. These negative vertical pulses produce a positive pulse in the plate circuit of V_{101A} which triggers the multivibrator consisting of both triode sections of V_{102}.

The multivibrator functions so that the right hand section is conducting for a long period of time while the left hand section is cut off for a long period of time. This is accomplished by returning the right hand grid to B+ through resistor R_{109}. The positive vertical pulse applied to the left hand grid of V_{102} causes the tube to conduct and through multivibrator action produces a positive pulse in the right hand plate circuit.

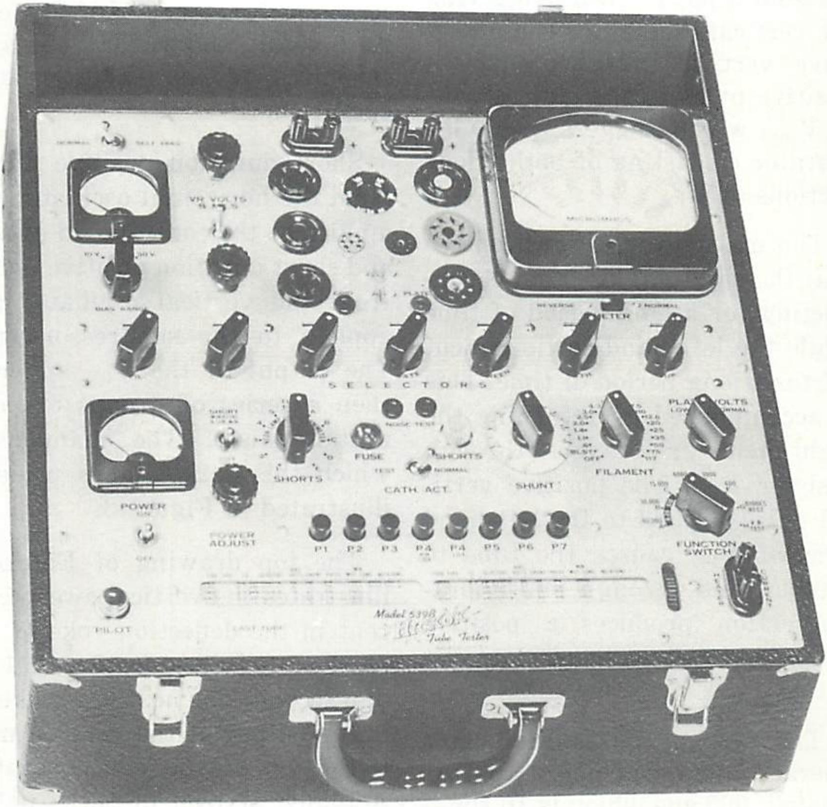
The vertical dot multivibrator operates at a frequency of approximately 960 cps which is 16 times the frequency of the 60 cps vertical input pulse. In operation, the actual frequency can be varied by potentiometer R_{106} which is the vertical sync control. Thus, the oscillator is free-running during the intervening fifteen cycles.

Negative horizontal pulses are fed to the left hand grid of V_{103} which is the same type of multivibrator explained for the V_{102} stages except that the components are chosen to allow the multivibrator to oscillate at a frequency of about 378 kilocycles which is about 24 times the horizontal scanning frequency of 15,750 cps. As a result, the oscillator is synchronized on every 24th cycle of operation.

Short duration positive pulses from the horizontal oscillator are applied to the control grid of V_{104} and short duration positive pulses from the vertical oscillator are applied to the suppressor grid. The output of the V_{104} adder is then a series of groups of horizontal pulses. The manner in which this action takes place is illustrated in Figure 3.

The top drawing of Figure 3 illustrates the vertical sweep current in the deflection yoke of the receiver for the duration of 1/60 of a second. The next lower sketch is the output of the vertical multivibrator of the dot generator. Actually, sixteen of these pulses occur during every cycle of the receiver vertical scanning system but only two are shown to make the drawing clearer. Below the vertical pulses is shown the positive pulse output of the horizontal multivibrator.

The 6AS6 tube, which is used as the adder, is physically constructed so that the positive vertical pulses applied to the suppressor grid permit the tube to amplify the horizontal pulses that are applied to the control grid at the same time. However, when the negative portion of the vertical pulses occurs, the tube is cut off and the horizontal pulses do not appear in the plate circuit. Thus, the output in the adder plate circuit is groups of horizontal pulses that are fed to the grid of V_{101B}. Once again, the number of pulses shown on the lower sketch of Figure 3 is reduced in number to permit them to be drawn clearly.



This transconductance tube tester is simple to operate and is a valuable piece of test equipment.

Courtesy Hickok Electrical Instrument Company

Amplified by V_{101B}, pulses of positive polarity appear in the plate circuit and are coupled through C_{108} and C_{109} to the output jack J_{101} on the front panel. As explained in a previous lesson, the red phosphor is less efficient than the blue and green phosphors of the three-gun color picture tube and must be driven harder to produce the same amount of light output. For this reason, one signal is taken directly from the plate and fed through C_{109} to the grid of the red gun while a signal reduced in amplitude is fed through C_{108} to the grid of the blue and green guns.

The picture tube adapter shown in the schematic diagram of Figure 2 is for use with the 15 inch electrostatic convergence type picture tube. However, another adapter can be obtained to be used with the larger color picture tubes. This adapter has only fourteen lugs to match the tube socket of the larger picture tube.

When using the Sylvania dot generator, the horizontal sync lead is capacitively coupled to the receiver yoke by fastening the alligator clip to one of the horizontal windings of the yoke. The vertical sync lead can be attached in the same manner to obtain the vertical sync signal and the ground lead attached to the chassis of the receiver.

With power applied to both units, the color TV receiver should be tuned to a TV channel so that the sweep circuits in the receiver will be stabilized. Adjust the contrast and brightness controls until the received picture and background illumination disappears and only the white dots remain. The convergence adjustments can now be made according to the procedure suggested by the manufacturer or by following instructions that are given in a later lesson of this series.

RCA WR-36A Dot-Bar Generator

The RCA dot-bar generator, the block diagram of which is shown in Figure 4, is designed to produce a choice of vertical bars, horizontal bars, crosshatch pattern, or a white dot pattern. The number of dots can be varied from about 14 to 18 dots in a vertical row and 9 to 15 dots in a horizontal row by means of the Horizontal Bar and Vertical Bar controls on the front panel.

This generator provides either a positive or negative polarity video signal which can be fed directly to the first video amplifier of the TV receiver or it provides a modulated r-f signal that is continuously tunable to cover channels 2 through 6.

Referring to the block diagram of Figure 4, sync pulses at a frequency of 60 cps are fed into V_{1A} where they are amplified and fed to the V_{1B} stage which is the vertical sync keyer. The keyer stage synchronizes the horizontal bar oscillator to a frequency between 480 to 900 cycles per second. The exact frequency is determined by a control that is in the grid circuit of the V_{2A} oscillator stage.

A point of considerable interest here is that the horizontal bar oscillator is synchronized by the vertical pulses from the receiver and the vertical bar oscillator is synchronized by horizontal pulses. In order to explain this, it should be remembered that a constant frequency video signal applied to the grid of a picture tube will produce bars depending upon the frequency of the video signal in respect to the frequency of the vertical or horizontal scanning frequencies.

For example, if a video signal at 120 cps is applied to the grid of the CRT, two horizontal bars appear because two cycles of the input signal occur during the vertical scanning period. A signal at 600 cps causes 10 horizontal bars and a signal at 900 cps causes 15 horizontal bars. Consequently, if the applied signal is a multiple of the vertical scanning frequency, horizontal bars will be produced.

This situation continues until the frequency of the applied signal is equal to or greater than the frequency of the horizontal scanning system. When a signal at 15,750 cps is applied to the grid of the CRT, one vertical bar appears. If the signal frequency is increased to 157,500 cps, 10 vertical bars are present as the signal modulates the grid of the CRT ten times during each horizontal scanning cycle. If the applied signal is synchronized with the horizontal sweep signal, modulation of the CRT electron beam occurs at exactly the same points during each horizontal trace and produces vertical bars. In practice, the number of visible bars is slightly less than the calculated number because some of them occur during the retrace period and do not show up on the screen of the CRT.

Getting back to Figure 4, horizontal pulses from the receiver are amplified by V_{4A} and fed to the horizontal sync keyer which synchronizes the vertical bar oscillator V_{2B} at a multiple of the horizontal sweep frequency. The diode clamps in the output of the two oscillators permit only the positive portions of the signals to be applied to the mixer and shaper stage V_5.

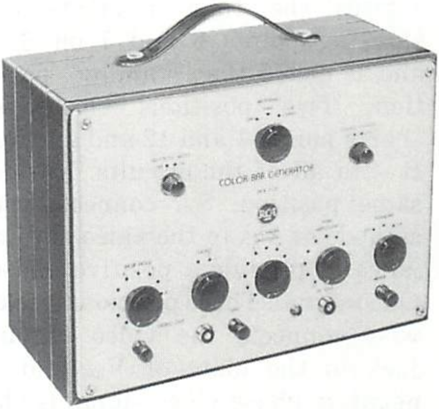
The combined signal, which is very similar in appearance to the output of the Sylvania dot generator, is fed to the video output stage and to the r-f oscillator. Diode clamp CR_2 shapes the signal according to whether a dot pattern or a crosshatch is desired.

A complete schematic diagram of the RCA dot-bar generator is shown in Figure 5. Depending upon the setting of the vertical sync selector switch S_1, a signal is obtained externally or internally to synchronize the horizontal bar oscillator. As shown, an external pulse is amplified by V_{1A} and applied to the grid of the keying tube V_{1B} as a positive polarity pulse which causes a heavy conduction of V_{1B}. The plate current of this tube must pass through coil L_1, which is used in conjunction with the V_{2A} circuitry as a Hartley oscillator, and dampens the tuned circuit to the extent that oscillations cease. At the end of the sync pulse, conduction of V_{1B} is reduced considerably and the horizontal bar oscillator begins to function. In this way, the oscillator is started at the beginning of every vertical scanning cycle in the receiver and will continue to oscillate at a frequency determined by the circuit components and the setting of R_{10} in the grid circuit of V_{2A}.

The vertical bar oscillator functions in the same manner and is synchronized by horizontal pulses that are amplified by V_{4A} and applied to the grid of the horizontal keyer which cause it to conduct heavily. As described for the horizontal bar oscillator, this action causes the vertical bar oscillator to be synchronized by the input pulses. The actual frequency of operation can be varied by the screwdriver slug adjustment in L_4.

Before being applied to the grids of the double triode V_5, the signals from the oscillators are rectified by CR_1 and CR_3 so that only the positive peaks affect the conduction of V_5. Developed across the common plate load resistor R_{30}, the combined signals are fed through C_{20} to the grid of V_{3B} and through the network of R_{17}, C_9, and L_3 to the plate of the r-f oscillator, V_{3A}, where they modulate the r-f signal.

The choice of patterns is determined by the position of PATTERN SELECTOR gang switch S_2. In the illustrated position, the connections of S_{2B} cause B+ to be applied to the plate of the vertical bar oscillator but not to the plate of the horizontal bar oscillator, thus providing a vertical bar pat-



The color-bar generator pictured here operates on the offset signal method and produces a pattern of vertical color bars.

Courtesy Radio Corporation of America

tern. Turning the switch one position clockwise reverses the situation and permits the horizontal bar oscillator to function. Turning the switch two positions clockwise permits both oscillators to operate and affects the manner in which CR_2 is connected into the plate circuit of V_5. This action results in the production of the dot pattern. The fourth position reverses the connections of CR_2 and makes a crosshatch pattern available.

The choice of output is determined by VIDEO R-F switch S_3. Turning it one position clockwise from its present "off" position energizes the tube filaments by shorting points 6 and 7 on S_{3B}, and is called the "standby" position. Two positions clockwise shorts points 1 and 12 and applies B+ to all of the circuits. In this same position, S_{3A} connects the cathode of V_{3B} to the video output jacks to provide a positive phase video signal. Three positions clockwise connects the video output jack to the plate of V_{3B} and a negative phase video signal is obtained. Four positions clockwise removes the video signal from the output jack and applies B+ through R_{18} and R_{16} to the screen grid of the r-f oscillator. This switching permits the oscillator to function and produce a modulated r-f signal in its plate circuit.

To obtain the dot pattern on the receiver, apply power to the generator and the receiver and allow an adequate warm-up period. To use the RF output signal, connect the generator r-f output jack to the receiver antenna terminals and the ground lead to the receiver chassis after the receiver controls have been adjusted while receiving a regular telecast. A lead connected to the generator horizontal sync jack should be loosely coupled to the deflection yoke by clipping it to the insulation of the hot lead to the horizontal windings.

The vertical sync selector is set to the internal or LINE position, the pattern selector to DOT and the VIDEO/R-F selector to RF. With the receiver tuned to an unused channel, the generator is set to the same channel. The dot pattern can be locked in by adjusting the receiver vertical hold control and the Bar controls on the generator.

If it is desired to use the video signal instead of the r-f signal, a coaxial cable is connected to the video output jack and the signal fed to the grid of the first video amplifier in the receiver. Then the VIDEO/RF selector switch is turned to either VIDEO+ or VIDEO−. Whichever setting gives white dots on a black background is the correct setting. Once again, the actual convergence procedure will be explained thoroughly in a later lesson.

Naturally, there are many other generators on the market that will provide a signal suitable for making the convergence adjustments in a color TV receiver. Among these is the Hickok Model 650C Universal Video Generator. This instrument also supplies either video or modulated r-f output signals. It is considerably more complex in design than the two generators already explained and employs a crystal controlled master oscillator to produce dot and bar patterns that are extremely stable. A complete description of the instrument and its uses are contained in the instruction booklet accompanying each generator.

COLOR BAR GENERATORS

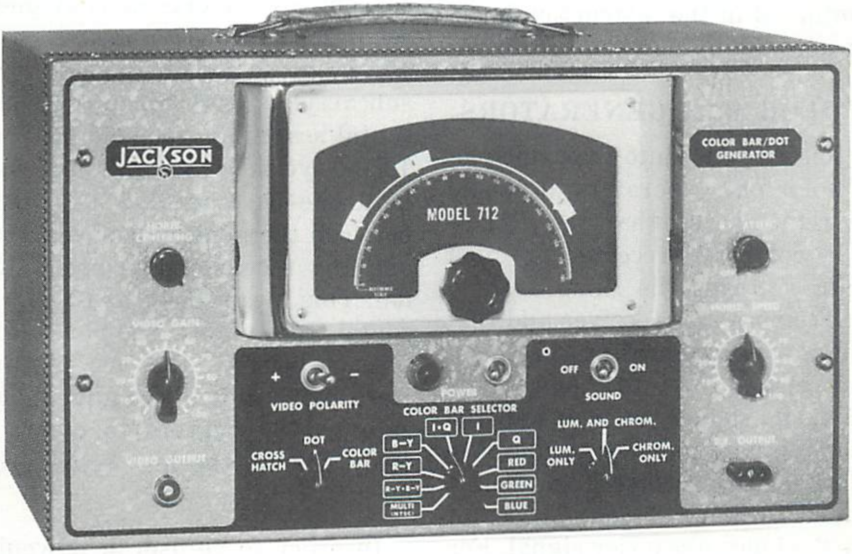
Before going into the principles of color bar generators, it should be remembered that the signals in a color TV receiver are just plain voltages the same as in a black-and-white receiver and that colors are produced by the chemical makeup of the phosphors. Also, it should be remembered that the various hues produced in a color TV receiver are determined by the different phases of the 3.58 mc subcarrier signal. For example, if the subcarrier signal is phase shifted 120 degrees from the zero reference point and applied to the demodulators in the receiver, orange will be produced; if the signal is phase shifted 60 degrees from the zero reference point, magenta will be produced. Furthermore, a continuous change of the subcarrier signal through the full 360 degrees of one cycle during one horizontal cycle will cause a continuous spectrum or rainbow of colors to appear on the screen, except for the small portion lost during horizontal retrace.

There are several methods by which the color-bar signals can be produced and one of these is called the "offset signal" method. Instead of using a 3.579545 mc subcarrier signal, the **offset signal generator** employs a crystal controlled oscillator at 3.563795 mc which is 15,750 cps less than the standard subcarrier signal. Since the horizontal scanning frequency is also 15,750 cycles per second there will be a one-cycle-per-line difference between the generator subcarrier and the receiver subcarrier signal. This means that, as the horizontal trace occurs, the phase difference between the two subcarriers will gradually change from zero to 360 degrees to continuously change the hue being produced.

In order to be useful, it would be much better if a different hue could be produced every 30 degrees to produce a vertical bar pattern of 12 different colors. This can be done by keying the 3.563795 mc generator signal on and off at a frequency which is twelve times the horizontal scanning frequency or 189 kc. To this signal can be added the horizontal sync pulse to obtain a signal like Figure 6. When this is done the horizontal sync pulse replaces the first group of sub-carrier signals and the second group is used as the color sync burst. The remaining ten groups produce ten vertical bars of different hues which are as shown in Figure 7.

The color bar generator should be capable of providing both video and modulated r-f output signals. The r-f color signal provides a convenient means of feeding any color TV receiver and permits the technician to determine whether or not the over-all functioning of the receiver is proper. In the event of trouble, the video color signal will help to localize the defective stage as being ahead of or after the video second detector.

Another desirable feature of any color-bar generator is that it should provide a sound carrier as well as a picture carrier and both carriers should be crystal controlled. These features will enable the fine tuning control of the receiver to be adjusted properly



This combination color bar-dot generator represents most of the additional equipment necessary to service color TV receivers.

Courtesy Jackson Electrical Instrument Company and allow the color signals to pass through the i-f system without being distorted.

Finally, the generator must provide horizontal sync pulses so that the receiver scanning circuits will operate at the correct submultiple of the 189 kc bar oscillator.

RCA Color-Bar Generator

In Figure 8A is the block diagram of the RCA color-bar generator employing the "offset-signal" method of producing color bars. A crystal controlled subcarrier signal at 3.563795 mc is fed into the subcarrier keyer along with the 189 kc signal from the crystal controlled bar oscillator. Since 189 kc is the twelfth harmonic of the horizontal scanning frequency, the bar-oscillator signal gates the keyer on and off to allow the subcarrier signal to appear as twelve bursts in the keyer plate circuit during each horizontal scanning cycle.

The 189 kc bar oscillator also controls the horizontal sync generator which feeds a pulse through clamp stage V_{2A} to the keyer which, in turn, suppresses or counteracts one of the twelve pulses from the bar oscillator. The "space" left by this action has the horizontal sync pulse inserted into it when the output of the keyer and the horizontal sync shaper are mixed in the V_4 stage. The output of the mixer, which is illustrated in Figure 6, is fed to picture carrier modulator V_5 where it modulates the crystal-controlled r-f signal from the picture carrier oscillator. The modulated picture carrier, along with the crystal controlled sound carrier signal is fed to the r-f output jack.

The output of the mixer is also fed to the video amplifier which provides signals of low and high amplitudes in its output.

The metering circuit also is fed by the mixer and it provides a means for adjusting the peak to peak amplitude of the burst so that it is equal to the sync pulse amplitude. This could be done by observing the video output signal with a wide band oscilloscope but the metering circuit enables this to be done with a vtvm.

Since a considerable number of color-bar generators currently being manufactured operate on the offset signal principle, an understanding of the circuits used in this type of generator will be helpful. Accordingly, the schematic diagram of Figure 8B has been included.

Starting with the V_{1A} bar oscillator, the 189 kc signal is fed from its grid to the grid of the V_{1B} bar shaper. The positive portion of this signal causes grid current in V_{1B} to charge C_2. Since C_2 discharges through R_3 adjustment of the RC time constant determines the amplitude and width of the pulse which appears in the plate circuit.

From the screen grid of the bar oscillator, a signal is applied to the horizontal sync multivibrator V_6 and triggers it on every twelfth cycle of the bar oscillator. Positive horizontal pulses are fed through C_{19} to the grid of the shaper V_{2B} and to the grid of the V_{2A} clamp stage. In the plate of the clamp tube, a negative pulse appears at the same time a positive pulse from the bar shaper is applied. This prevents the keyer stage from being gated on during the horizontal sync pulse period and leaves the "gap" in the output of the keyer into which the horizontal sync pulse is inserted in the mixer stage.

The subcarrier oscillator signal from V_{3B} is fed to the grid of keyer tube V_{3A} where it appears in the keyer output as eleven bars of color signal. The twelfth bar is missing due to the horizontal sync pulse output from the clamp tube cutting off the subcarrier keyer during the horizontal sync pulse period.

A negative pulse from the output of V_{2B} is applied to the grid of V_{4B} and mixed in common plate resistor R_{10} with the eleven bars of the subcarrier signal which has been amplified by V_{4A}. The combined output, which has the opposite polarity to that shown in Figure 6, is applied through C_9 to the suppressor grid of the V_5 modulator stage. The 61.25 mc picture carrier signal is fed to the grid of V_5 where it is modulated by the subcarrier and sync signal. The 65.75 mc sound oscillator, V_{7B}, feeds its signal through C_{14} to the junction of R_{18} and R_{19} where it combines with the modulated picture carrier. Both signals are then fed to the r-f output jack.

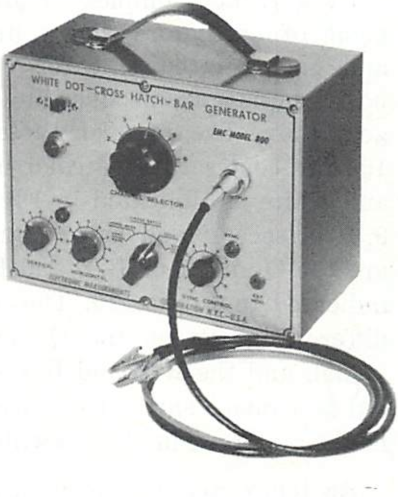
From the V_4 plates, the video color signal is also fed through C_{30} to the grid of V_{8A}. In the output of V_{8A} is a video polarity switch which selects either phase of the video color signal. In the drawn position, S_2 takes the signal from the cathode of V_{8A} and applies it to the grid of V_{8B}. When S_2 is rotated to its clockwise position, the signal from the plate circuit of V_{8A} is applied to V_{8B}. In either case, V_{8B} amplifies the video color signal and feeds it to the HI and LO video output jacks.

The metering circuit, mentioned previously, operates by applying the complete video signal from the suppressor grid of V_5 through the shielded cable to the switch S_3. In the "off" position shown, the signal is not used. However, moving the switch one position clockwise causes the signal to be applied to the low-pass filter of L_{10} and C_{37}, and allows the sync pulse portion of the complete signal to be applied through C_{43} to the crystal rectifiers CR_3 and CR_4. These rectifiers are connected as a voltage doubler and provide a negative d-c voltage at the meter output jack.

When the metering switch is turned two positions clockwise, the high-pass filter consisting of C_{36} and L_9 causes the subcarrier color signal to be applied to the metering circuit.

Located in the lower center portion of the diagram, modulation switch S_4 permits a 60 cps voltage to be applied through C_{38} to the cathode of V_{4B} where it is mixed with the video signal when the MOD button is depressed. This causes one light and one dark horizontal bar to appear on the face of the receiver CRT along with the vertical color bar. If the receiver circuits are functioning linearly, the brightness levels should be changed but the hues should remain the same.

To use the RCA color bar generator, the color receiver should be tuned to a local TV station and all receiver controls set properly for a black-and-white picture. Next, tune the receiver to channel 3 and connect the r-f output of the generator to the antenna input terminals. Turn the receiver color saturation control to its minimum position and adjust the contrast and brightness controls for a monochrome bar pattern. The horizontal hold control on the generator should be adjusted, if necessary, to lock-in the bar pattern. Slowly advance the receiver color saturation control until colors appear in the bars. The receiver hue control can now be adjusted to obtain the bar pattern illustrated in Figure 7.



A versatile instrument—this generator provides a variety of patterns including a white dot pattern and is tunable from channels 2 through 6.

Courtesy Electronic Measurement Corp.

If the correct bar pattern cannot be obtained, the video signal output of the generator can be fed to the grid of the first video amplifier in the receiver. This check will enable the technician to determine if the trouble is ahead of or after the video second detector.

Hickok Color Bar Generator

The second most common method of producing color bars is to feed the 3.58 mc subcarrier signal through a delay line and pick off the signal after it has been phase shifted by the proper amount. Using this system, the Hickok color-bar generator has been designed to the NTSC standards.

By a rather complex arrangement of oscillators, delay lines, and gating circuits, three composite signals are produced by the generator. The first of these is 100 per cent saturated color bars and white as indicated in Figure 9. The second and third signals are the Q and I, or B-Y and R-Y indicated in Figure 10. The only difference between the Q and I signal, and the R-Y and B-Y signal is a phase shift of 33° which is not apparent in the drawing.

Switches are provided which enable portions of these signals to be turned off to allow the technician to observe individual signals. For example, the chrominance component of Figure 9 can be turned off and only the brightness component shown in Figure 11 will remain. Further, the brightness component can be turned off and only the chrominance component shown in Figure 12 will remain. Other switches are provided which enable the Q (or B-Y) or I (or R-Y) signal of Figure 10 to be turned off and leave only one of them.

This flexibility of signal outputs can be very advantageous when aligning or trouble shooting the color sections of a receiver. For example, in the output of the color demodulators, when the generator is set to produce I and Q bars, the individual bars can be readily identified by switching off either signal and observing which bar disappears. In this way the hue control can be set so that the correct signals are produced in the output of each demodulator.

The output signals of the generator are available as video or as modulated r-f signals. A polarity reversing switch enables either phase of the video signal to be obtained, and the r-f signal can be set to channel 4, 5, or 6 even though it is pre-set at the factory for channel 5.

When using the output signal illustrated in Figure 9, various wave-forms are obtained at different points in the receiver depending upon the design of the receiver under test. If the receiver demodulates on the R-Y and B-Y axes, the observed waveforms in the color-difference circuits are as shown in Figure 13. The upper left wave-form is produced in the output of a R-Y demodulator while the upper right wave-form is produced by a minus (R-Y) demodulator. An examination of the two top wave-forms reveals that they are exactly opposite in polarity but the same in all other respects. The output of the B-Y modulator is shown in the middle wave-forms of Figure 13, the right wave-form being the negative polarity signal and the left wave-form the positive polarity signal.

The lower wave-forms are the G-Y signal and can be obtained in the receiver by a G-Y demodulator or by mixing proper amounts of the R-Y and B-Y signals.

Figure 14 shows the wave-forms that are observed in a receiver when I and Q demodulators are used. Once again, the left wave-forms are the positive polarity signals while the right wave-forms are the negative polarity signals.

In Figure 15, the upper wave-form is produced at the grid of the red gun, the middle wave-form at the grid of the green gun and the lower wave-form at the grid of the blue gun when the receiver under test mixes the luminance signal with the color signal in the matrix and applies the combined signals to the grids.

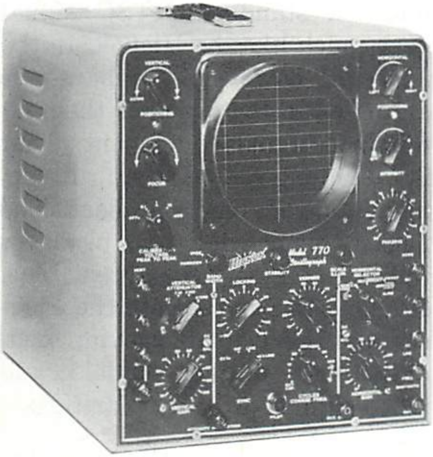
If the luminance or "Y" signal is fed to the cathodes and the chrominance signal to the grids, the wave-forms at the grids of the color CRT will be as shown in the left hand column of Figure 13.

There are several other color-bar generators on the market which are also excellent for use with a color TV receiver. Among these is the Triplett Model 3439 which operates on the same principles as the RCA and produces color bars that are almost identical.

Another color-bar generator is the Jackson Model 712 that produces a standard NTSC signal very much like the Hickok. In the Jackson, however, the bars are arranged in the order of their luminance signal component. That is — white, yellow cyan, green, magenta, red, blue and black. The Jackson generator also produces individual I, Q, red, green, blue, R-Y and B-Y bars. Both the Jackson and the Triplett provide modulated r-f output signals and video signals of both polarities.

OSCILLOSCOPES

Until the advent of color television, the oscilloscopes used for aligning and servicing TV receivers did not need a wide band response in the vertical amplifiers. Even though the video signal contains frequencies up to 4 mc, there is no necessity for observing the higher frequency video signals. In fact, even if the scope were able to reproduce them, the conventional sweep circuits in the scope cause the information on the active scanning lines (about 500) to be superimposed on each other resulting in a useless signal. Accordingly, the scopes were designed to accurately reproduce the horizontal sync pulses as these are the highest frequency components that must be observed. This can be accomplished if the vertical amplifier circuits have a flat response to about 500 kc.



The high quality oscilloscope pictured here is designed to reproduce the 3.58 mc color signals without attenuation or distortion.
Courtesy Hickok Electrical Instrument Company

The same situation holds true for most of the applications of the scope in color TV servicing. However, there are several measurements that must be made in a color TV receiver that require the use of an oscilloscope in which the vertical amplifier circuits have a flat response to about 4.5 mc. Among the signals that cause the increased demands on the scope are the 3.58 mc burst, the 3.58 mc local subcarrier oscillator, and the chrominance signals. It is true that it may be possible to observe these signals on a narrower band scope but they would be severely attenuated in amplitude and the actual voltage cannot be determined. To be of any real value, it is necessary to know the amplitude and shape of these signals.

The determining of actual amplitudes also points up the need for a calibration system which is flat over the entire range of frequencies being observed. For this purpose, the wide-band scopes incorporate a capacitance compensated step attenuator in the vertical input circuit.

Jackson CRO-2 Scope

In order to meet the need for a wide-band scope for certain applications and high sensitivity for others, many scope manufacturers have designed a combination unit. In Figure 16A, the block diagram of the Jackson Model CRO-2 is shown. Starting at the vertical input terminals, the signal is fed to a **step attenuator** (ATT) which permits reduction of the signal by factors of 10 and 100. A 60 cycle calibration voltage is made available at this point to enable the technician to determine peak to peak voltages accurately. From the attenuator, the signal is fed to the 6C4 cathode follower which has a variable gain control (not shown) feeding the signal to the 6J6 vertical amplifiers. The output of the final push-pull vertical amplifier is fed to a switching arrangement which allows a polarity reversal of the signal fed to the vertical deflection plates.

The horizontal sweep oscillator, 6J6, can be synchronized by a 60 cps voltage, a 120 cps voltage, externally, or internally by a signal derived from the vertical amplifier. Its output is fed to the 6C4 cathode follower and further amplified by the push-pull 6J6's before being applied to the CRT horizontal deflection plates. The sweep oscillator also provides a positive pulse which is amplified and inverted in polarity by the 6C4 blanking amplifier. It is then applied as a negative pulse to the grid of the CRT to blank out the electron beam during horizontal retrace.

Since the primary requisite of an oscilloscope suitable for use in color TV servicing is that the vertical amplifiers be capable of passing a band of frequencies from about 30 cps to 4.5 mc, a detailed examination of such vertical circuits will be helpful. Therefore, in Figure 16B is shown the vertical circuits for the Jackson Model CRO-2 oscilloscope.

The signal to be observed is fed through C_1 to the step attenuator consisting of R_1C_2, R_2C_3, R_3C_4 with switch S_{1A} determining the attenuating factor. With the switch as shown, all of the input signal is applied to the grid of V_1. When the switch is moved to contact terminals 2 and 5, that portion of the input signal developed across R_1C_2 is not used and only that portion developed across R_2C_3 and R_3C_4 is applied to the grid of V_1. In this circuit R_1 is 1.3 megohms, R_2 is .13 megohms and R_3 is 15,000 ohms so that, in the second position of S_{1A}, a reduction factor of ten is obtained. When S_{1A} contacts lugs 3 and 6, only that portion of the signal developed across R_3C_4 is used to give a reduction factor of 100.

In any attenuation network where a wide band of frequencies is involved, it is necessary to shunt each of the divider resistors by a capacitor to prevent the high frequencies from being attenuated more than the low frequencies. This attenuation of the high frequencies is caused by the distributed capacitance of the attenuator network and the input capacitance of V_1. Since it is impossible to predetermine the exact amount of the distributed and input capacitance, it is necessary to make C_2 and C_3 variable and they can be adjusted so that all frequencies up to 4.5 mc are attenuated equally.

In the output of cathode follower V_1, potentiometer R_5 determines the amount of signal that is fed through C_8 to the lower grid of V_2. To prevent the high frequencies from suffering a loss of amplitude, R_5 must be a low resistance potentiometer (10 K in this scope).

Coupling from the lower half of V_2 to the upper half is accomplished by leaving the common cathode resistor, R_9, unbypassed. To be more explicit, when a positive polarity signal is applied to the lower grid of V_2 a positive polarity signal is developed across R_9. The upper grid of V_2 is at signal ground due to C_7 and the positive polarity signal across cathode resistor R_9 is effectively a negative polarity signal at the upper grid of V_2, therefore, the signals in the V_2 plate circuits will be opposite in polarity.

To develop sufficient signal across R_9, it must be large (5000 ohms in this case) in respect to other cathode resistors, but current in R_9 would bias V_2 almost to cutoff. This large bias voltage is counteracted by applying a positive voltage to both grids through R_{43} and R_8.

The component arrangement in the plate circuits of V_2 is almost identical to the circuitry of a video amplifier. The peaking coils L_2, L_3, L_4 and L_5, along with the damping resistors R_{10} and R_{11}, are chosen to provide the necessary frequency response. As previously mentioned, this oscilloscope is designed to provide high gain with narrow bandwidth in the vertical amplifiers or wide-band response with reduced gain. This selection is accomplished by switches S_{1B} and S_{1C}.

In the position shown, S_{1B} effectively places R_{16} in parallel with R_{15}, and R_{13} in parallel with R_{12}. This arrangement is shown more clearly in the partial schematic of Figure 17. It should be recalled that the B+ point is ground as far as the signal is concerned due to the capacitors connected from B+ to ground. Figure 17 shows that R_{16} and R_{13} are connected through S_{1B} to the positive plate of C_{30}. Being a large capacitor, C_{30} places this point at ground potential as far as the signal is concerned so that B+ and the positive plate of C_{30} are at signal ground potential. The only reason for inserting R_{14} into the circuit is to maintain a fairly constant B+ voltage available for the V_2 plates regardless of whether the switch is in the wide-band or narrow-band position.

Going back to Figure 16B, with S_{1B} in any one of the first three positions, R_{16} parallels R_{15}, and R_{13} parallels R_{12} to reduce the plate load of each half of V_2. In turn, a reduction of gain permits a wider band of frequencies to be passed with uniform response. In positions 4, 5, and 6, resistors R_{16} and R_{13} are not connected and the plate loads are increased to the values of R_{15} and R_{12}, resulting in greater gain with reduced frequency response.

From the V_2 plate circuits, opposite polarity signals are fed through C_9 and C_{10} to the grids of V_3. Peaking coils L_6, L_7, L_8, and L_9 perform the same function as the peaking coils in the V_2 plate circuits. Also, switch S_{1C} places R_{23} in parallel with R_{22} and R_{25} in parallel with R_{24} in the same manner as described for S_{1B} in the V_2 plate circuits. The V_3 output signals are then fed to polarity reversing switch S_3. Finally, from S_3 the signals are fed through C_{12} and C_{11} to the vertical deflection plates of the cathode ray tube.

Other factors which must be taken into consideration when evaluating the usefulness of a scope is the input resistance and capacitance. For best results, the input resistance should be as high as possible and the capacitance as low as possible to prevent the scope from affecting the circuit under test. Besides these, the deflection sensitivity and trace brightness are also important considerations. The **deflection sensitivity** is a measure of the amplitude of the input signal necessary to produce one inch of deflection. This means that a scope requiring .5 volts per inch of deflection has less gain than one requiring only .1 volts per inch of deflection. In practice, a deflection sensitivity of .5 volts per inch is the minimum sensitivity acceptable.

The 21 inch color TV receiver pictured here is an example of what the servicemen will encounter. Notice the few customer operating controls.

Courtesy Radio Corporation of America

At the present time there are a considerable number of oscilloscopes on the market that are highly satisfactory for color TV service work and complete specifications are supplied by the various manufacturers.

ALIGNMENT GENERATORS

The video information contained in a black-and-white telecast covers a range of frequencies up to 4.1 mc the same as in a color telecast and monochrome TV receivers should be designed to pass these high modulating frequencies. However, the only effects that are noticed if the response falls off at 2 or 2.5 mc is the loss of fine details. Because of this, many of the monochrome TV receivers in use today are designed to pass this narrower band of frequencies to take advantage of the increased signal to noise ratio that can be obtained.

In color receivers this situation is not permissible as the tuner and the i-f circuits must be capable of uniform amplification of the 3.58 mc color subcarrier and the sidebands. This means that all sideband frequencies up to 4.1 mc must be passed without any severe attenuation or phase shift. If the response is narrowed, it causes a reduction in the width of the sidebands with a resultant loss of color detail and causes cross-talk between the two demodulator channels due to the phase shift that accompanies the sideband attenuation.

Because of these undesirable effects, a high degree of accuracy is required of the marker generator and the sweep generator. In fact, the marker generator should be crystal calibrated and the sweep generator output should be flat for at least 5 mc either side of the center frequency. The amplitude of the sweep generator signal should be at least .1 of a volt in order to check and align the r-f tuners. The frequency coverage should include the i-f bands up to 50 mc and the VHF channels on fundamental frequencies.

The marker generator should have built in crystal accuracy and should cover the entire r-f and i-f ranges on fundamental frequencies. It is also desirable that a 4.5 mc crystal for aligning intercarrier sound systems and a 3.58 mc crystal for the color circuits be included or provisions made for the insertion of these crystals into the generator circuits.

Since familiarity with the make-up of a sweep generator will enable the technician to use it with a higher degree of confidence, Figure 18 is the block diagram of the Hickok Model 695 sweep generator. The high band sweep oscillator is frequency modulated by a reactance tube to generate a 0 to 15 mc FM sweep and is continuously variable on fundamentals to cover channels 7 to 13. The low band sweep oscillator functions in the same manner as the high band sweep oscillator except that it is continuously variable to cover channels 2 to 6 on fundamentals.

The 220 mc fixed oscillator beats against the high band sweep oscillator to produce output frequencies that vary from 0 to 50 mc to cover the complete i-f range. A crystal mixer is employed for this heterodyne action because of its very linear output characteristics. The desired output is then fed through the attenuator to the r-f output jack.

Generally, the number of stages in a sweep generator are relatively few and the question might arise as to why many generators cost upwards of $100. In answer to this, attention can be called to the fact that the accuracy of the frequency output is very important and only high quality components are used. Besides this, the placement of the components is quite critical and requires carefully built units to obtain the best results. Finally, the methods of construction are quite different than those used for a radio or TV receiver and require more skill and time.

VIDEO SWEEP GENERATORS

Because of the simplicity of the video frequency section of a black-and-white TV receiver it is seldom necessary to investigate these circuits for anything but normal troubles such as defective resistors, capacitors, peaking coils, etc. In color TV receivers, this simplicity of construction no longer exists. After the received signal passes through the video second detector, the 3.58 mc subcarrier signal and the chrominance sidebands must be sent through properly aligned circuits in a manner similar to the regular i-f circuits. Since the bandwidth of these circuits is quite important, a **video sweep generator** is necessary for this alignment procedure. In a later lesson, the complete alignment procedure for these circuits will be analyzed in detail and only the requirements of the test equipment will be explained now.

A video frequency sweep generator should cover the video range from about 40 kc to 5 mc with a flat output and a maximum voltage of at least .1 of a volt. The sweep linearity—the number of megacycles per inch of horizontal deflection on the cathode ray oscilloscope — should be exceptionally good.

A **video frequency marker** should be used in conjunction with the generator to determine the bandwidth limits of the various sections. The most important marker frequencies are .5 mc, 1.5 mc, 2.5 mc, 3.58 mc, and 4.5 mc. The .5 mc marker is for checking alignment of the filter network in the output of the Q demodulator (or R-Y and B-Y); the 1.5 mc marker for the filter network in the output of the I demodulator; the 2.5 mc marker for aligning the chrominance band-pass filter; the 3.58 mc marker for the chrominance band-pass filter; and the 4.5 mc marker for the sound i-f circuits and traps.

This isolation transformer is a handy piece of equipment when the receiver under test does not use a power transformer. Notice the selection of AC voltages that are available.
Courtesy Chicago Standard Transformer Co.

The markers can be a c-w oscillator signal which is added to the sweep signal or an absorption type marker. The absorption type marker is preferable as it does not produce any harmonic signals and it does not overload the circuits under test as some c-w oscillator markers will. When using the absorption type marker, which consists of a very stable tuned circuit loosely coupled to the output of the video sweep generator, a notch or dip in the response curve is produced at a point corresponding to the frequency of the marker tuned circuit.

For best results a crystal controlled oscillator should be used for aligning the 3.58 mc color burst circuits and some of the 4.5 mc circuits, such as the 4.5 mc trap, and the secondary of the sound second detector.

The oscilloscope used to observe the sweep wave-forms can be either a wide-band type or a narrow-band type. Then using a wide-band scope, the output of the circuit under test is fed directly to the scope vertical input terminals and the actual video frequency output is observed. When using a narrow-band scope, a demodulator probe must be used to rectify the output of the circuit under test and apply the envelope of the rectified signal to the scope. Since the sweep repetition rate of the generator is 60 cps, the low frequency response of the scope must be very good or an undesirable tilt of the response curve occurs.

PROBES

Color TV service technicians will find an ever increasing use for probes. Among the most necessary probes for color TV work are the demodulator probe, the crystal diode probe and the d-c high voltage probe.

Demodulator probes, a circuit diagram of which is shown in Figure 19, are crystal diode rectifiers designed basically to demodulate high frequency signals and permit observation of the modulation envelope on an oscilloscope. The RC time constant in the rectifier circuit is designed to eliminate the high frequency component of the signal being measured and permit the low frequency modulation to be applied to the scope.

Since crystal rectifiers are contained in the probe, it should not be used where the d-c voltage exceeds 250 volts or where the a-c voltage exceeds about 30 volts peak. It will function satisfactorily with r-f signals from 500 kc to about 250 mc and will reproduce modulating signals from 30 to 5000 cycles. Thus, it is suitable for use in the color circuits of a color TV receiver as well as in the i-f circuits.

The crystal diode probe, shown in Figure 20, is similar to the demodulator probe in that it employs a crystal rectifier and an r-c circuit to perform the necessary filtering. However, it is designed to be used in conjunction with a vtvm to measure the rms values of sine waves. Its frequency range is from 50 kc to 250 mc while its voltage limit is 250 volts d-c and 30 volts peak a-c.

The last probe mentioned, and one of the most important, is the high voltage probe which is very simple in theory consisting merely of a high value resistor encased in an insulated holder. However, it is very important that the probe used to measure the high voltage in a color TV receiver should be very accurate.

It is common knowledge that the average beam current in a picture tube varies, with the current being more for bright scenes than it is for dark scenes. These changes in current cause the high voltage to vary in an inverse proportion. That is, when the beam current increases the high voltage decreases, when the beam current decreases the high voltage increases. These changes of voltage have no noticeable effect in a monochrome receiver but affect the purity and convergence in a color TV receiver. For this reason, the high voltage power supply in color receivers is regulated to maintain a constant voltage even though the beam current varies. Accordingly, the high voltage must be measured accurately and regulation adjustments made before the purity and convergence adjustments are made.

In color receivers the high voltage will vary from 18,000 to 30,000 volts depending upon the size and type of picture tube, and it is necessary to employ a probe in conjunction with a voltmeter that is capable of accurate measurements up to 50,000 volts. When choosing a high voltage probe for these measurements, the technician should make certain that its safety features include an anti-corona type grip and a long, low loss leakage path.

OTHER EQUIPMENT

Besides the test equipment already described, there are many other units that might be useful to the service technician. Among these are a tube tester, a capacitor checker and a Q meter. It is always a good policy for any service shop to have a reliable tube tester and it is even more important when doing color TV servicing. A tester, such as a mutual conductance type, will enable the service technician to locate noisy, microphonic, low-emission, gassy and other defective tubes that might not be discovered by an emission type tester.

Since there are so many additional components in a color TV receiver, the job of checking capacitors can be very time consuming if it is necessary to disconnect one lead of the capacitor before checking it. Accordingly, capacitor checkers have been developed that enable the worth of a capacitor to be determined while it is connected in the receiver.

The Q meter is a device which is capable of measuring the inductance and Q of a coil. With the additional coils and tuned circuits in the chrominance and 3.58 mc subcarrier oscillator circuits, it is quite likely that these components are going to cause trouble by developing shorted turns, changing value or the r-f resistance of the wire increasing. These types of defects cannot be detected by an ohmmeter measurement and can cause the technician to lose a considerable amount of time in locating them.

After reading through this lesson, it may seem that the amount of test equipment necessary to service and align color TV receivers is going to be a major expense item. However, a gradual acquisition of this equipment will ease the pain of paying for it. The most necessary items are a VTVM or a good voltmeter with a 20,000 ohms-per-volt rating which is also capable of measuring resistances of at least 100 megohms; an oscilloscope with the specifications as described in the lesson; a dot generator for making convergence adjustments, a color-bar generator for troubleshooting the color sections of the receiver, and a high quality tube tester. Other pieces of equipment can be obtained as the amount of color TV service work increases or as the technician feels that it will be sufficiently useful to pay for itself.

So far, in the color TV series of lessons, explanations have been primarily concerned with the theory of operation of the receivers and the equipment necessary to service them. In the succeeding lessons, installation, troubleshooting and alignment of the receivers will be covered in detail along with the manner of connecting the test equipment. The wave-forms that should be obtained at various points when the color sections are operating normally and the wave-forms that will be obtained when various difficulties occur will be analyzed in detail.

* * *

IMPORTANT DEFINITIONS

COLOR-BAR GENERATOR—A generator which produces a pattern of color bars. It is used for checking and adjusting the color sections of a color TV receiver.

CROSS-HATCH PATTERN—A combination of vertical and horizontal bars with equal spacing. The pattern is very useful for adjusting the linearity of the sweep circuits.

DEFLECTION SENSITIVITY—A measure of the voltage amplitude required at the input terminals of a scope to produce one inch of deflection on the CRT.

DOT GENERATOR—A generator which produces a white dot pattern on a dark background. It is used primarily for making the convergence adjustments in a color TV receiver.

OFFSET-SIGNAL GENERATOR—A type of color-bar generator in which the frequency of the sub-carrier oscillator is offset from 3.58 mc by the horizontal scanning rate. This results in a pattern of vertical color bars changing in hue from one side of the color CRT to the other side.

STEP ATTENUATOR—A circuit used in the vertical input circuit of an oscilloscope to permit the input signal to be attenuated without discrimination against the higher frequencies.

VIDEO FREQUENCY MARKER—A unit used in conjunction with the video sweep generator to align the video and chrominance sections of a color TV receiver. It produces pips or notches at points in the response curve corresponding to the frequency for which the marker is set.

VIDEO SWEEP GENERATOR—A sweep generator capable of covering a band of frequencies from about 50 kc to 5 megacycles. Its main use is in the video and chrominance sections to determine the band-pass of the various stages.

STUDENT NOTES

STUDENT NOTES

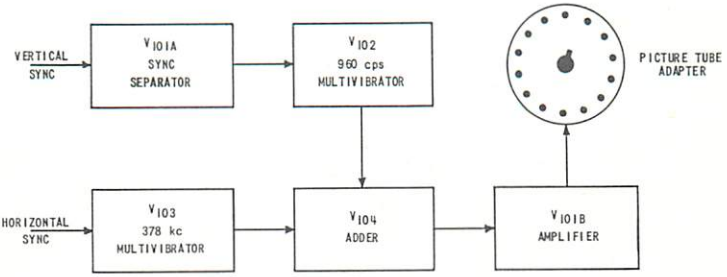


FIGURE 1

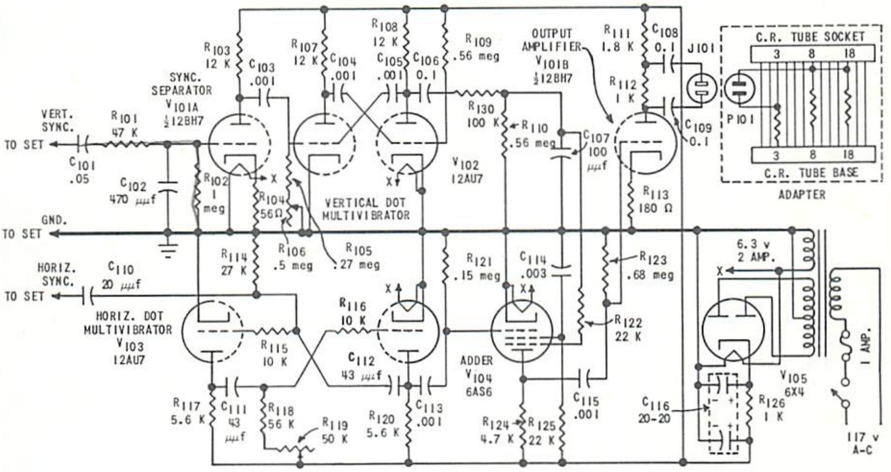


FIGURE 2

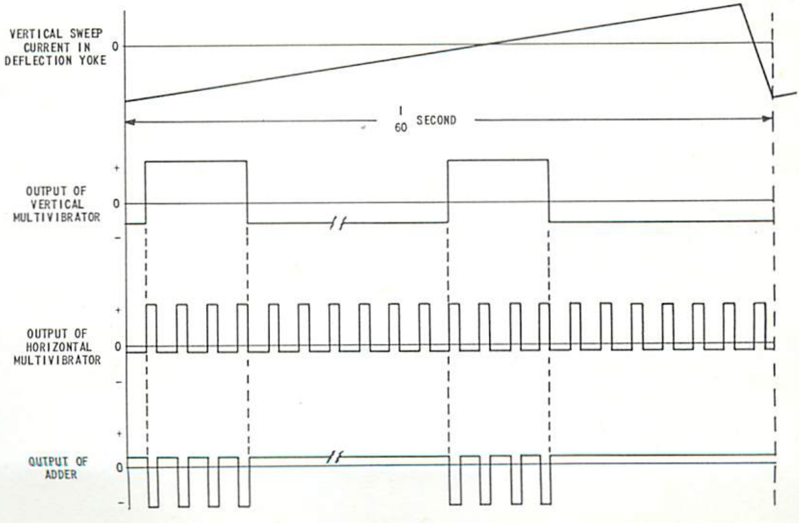


FIGURE 3

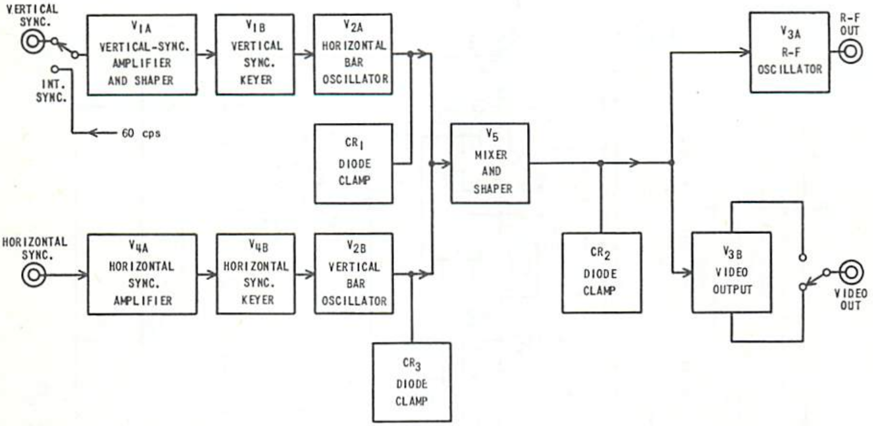

VERTICAL SYNC.
INT. SYNC.
60 cps
V_{1A} VERTICAL-SYNC. AMPLIFIER AND SHAPER
V_{1B} VERTICAL SYNC. KEYER
V_{2A} HORIZONTAL BAR OSCILLATOR
CR_1 DIODE CLAMP
V_5 MIXER AND SHAPER
CR_2 DIODE CLAMP
V_{3A} R-F OSCILLATOR
R-F OUT
V_{3B} VIDEO OUTPUT
VIDEO OUT
HORIZONTAL SYNC.
V_{4A} HORIZONTAL SYNC. AMPLIFIER
V_{4B} HORIZONTAL SYNC. KEYER
V_{2B} VERTICAL BAR OSCILLATOR
CR_3 DIODE CLAMP

FIGURE 4

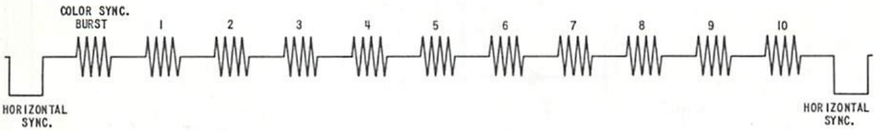


FIGURE 6

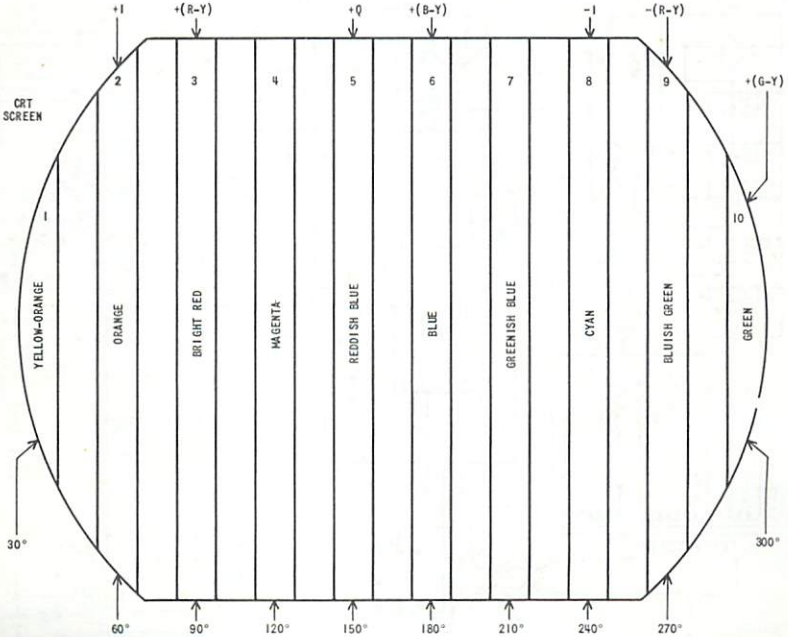
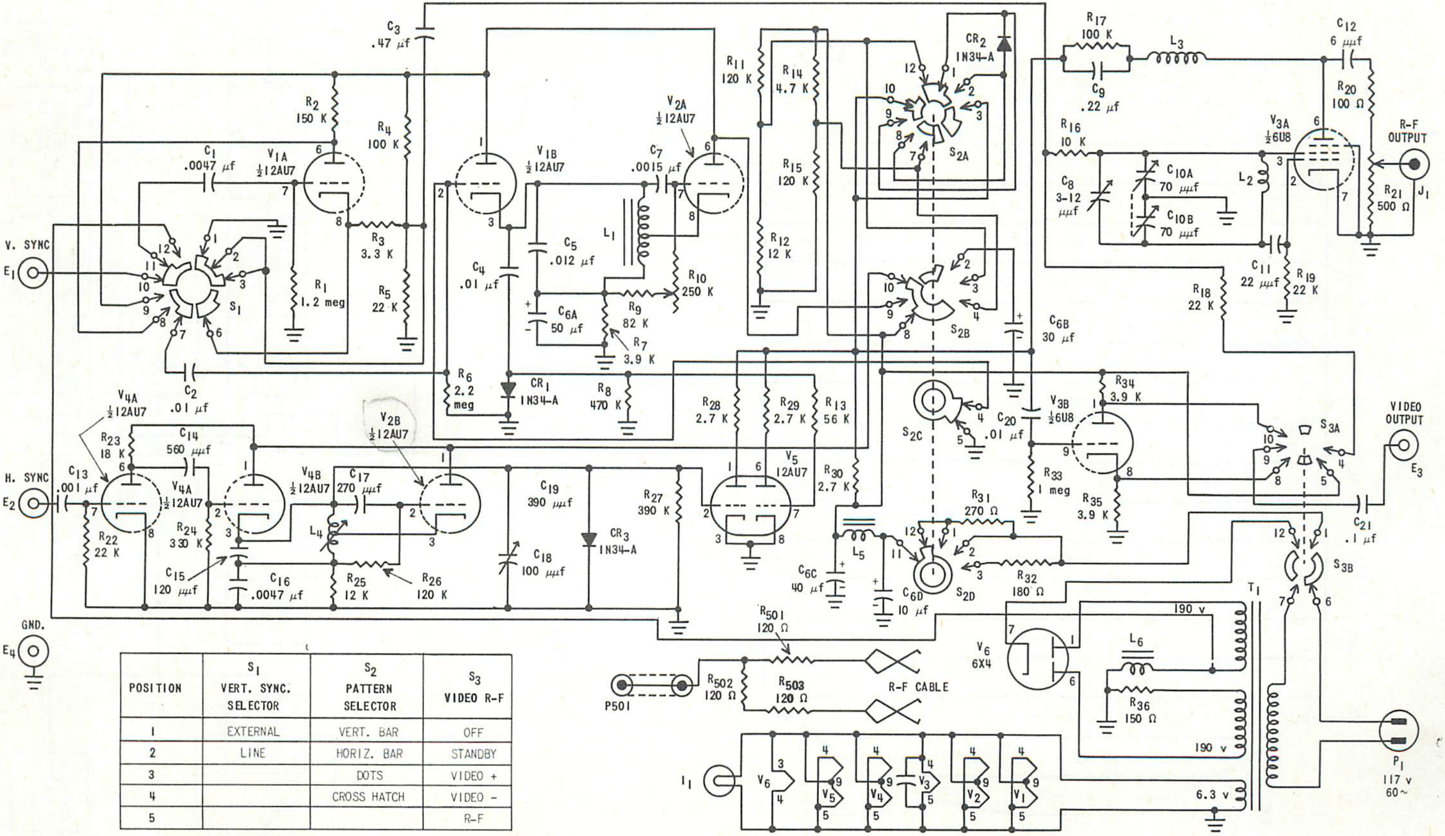


FIGURE 7



POSITION	S_1 VERT. SYNC. SELECTOR	S_2 PATTERN SELECTOR	S_3 VIDEO R-F
1	EXTERNAL	VERT. BAR	OFF
2	LINE	HORIZ. BAR	STANDBY
3		DOTS	VIDEO +
4		CROSS HATCH	VIDEO -
5			R-F

FIGURE 5

T4E-12

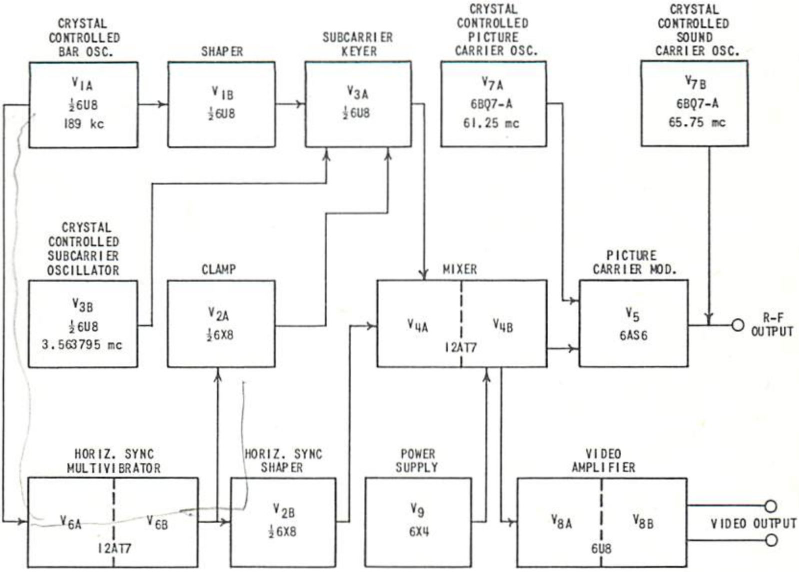


FIGURE 8 A

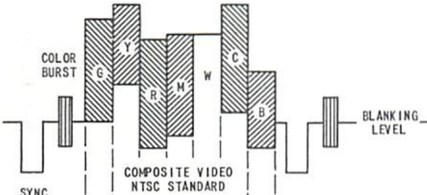


FIGURE 9

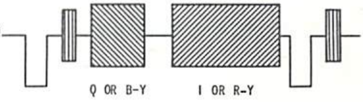


FIGURE 10

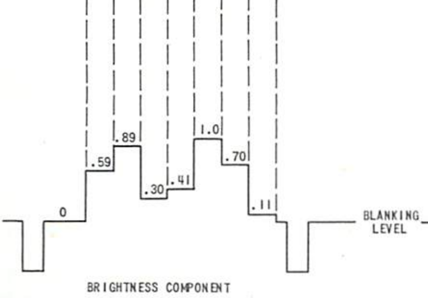


FIGURE 11

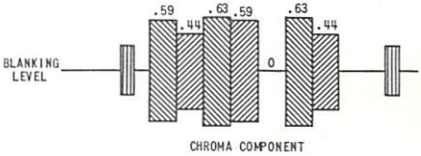
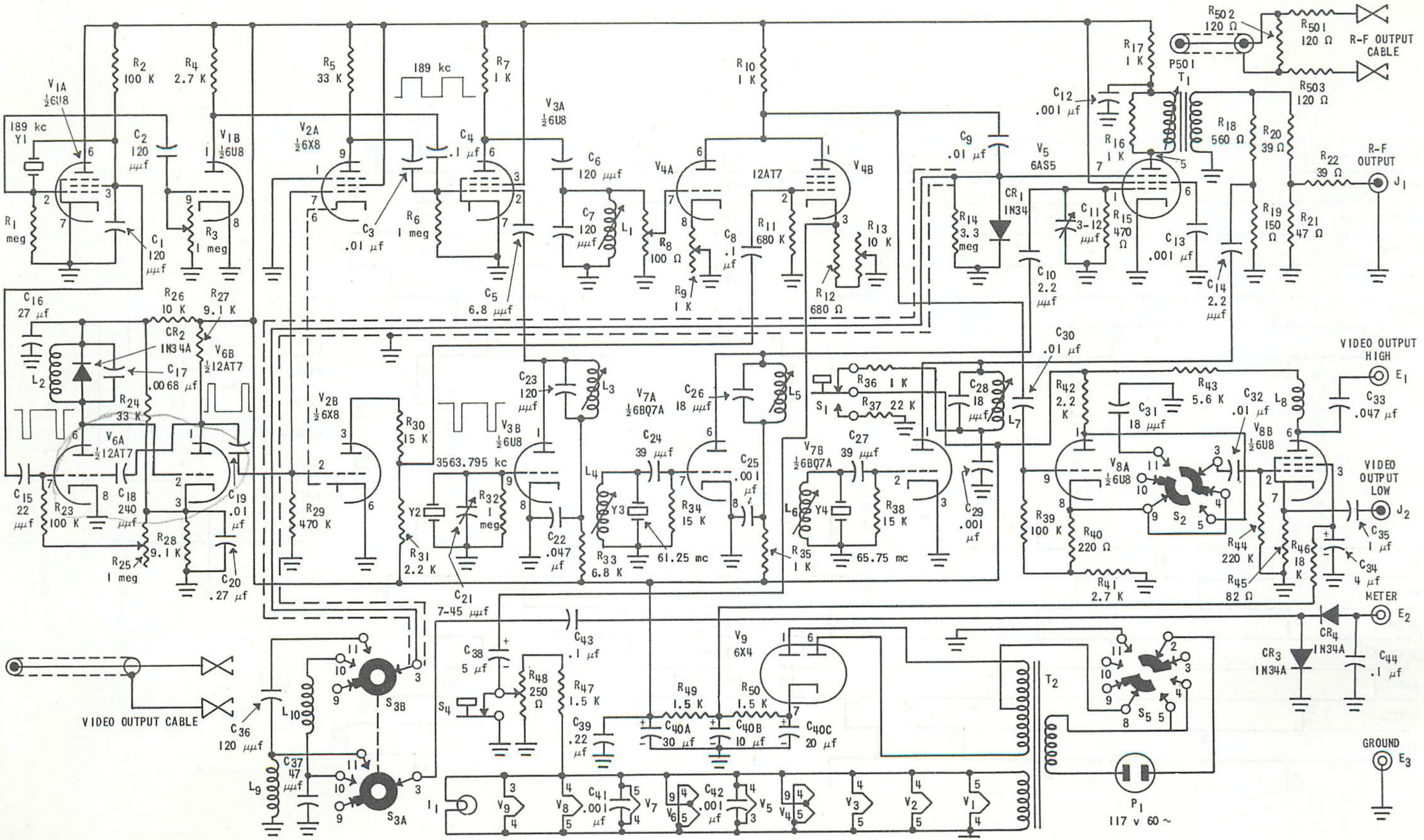


FIGURE 12



T4E-12

FIGURE 8 B

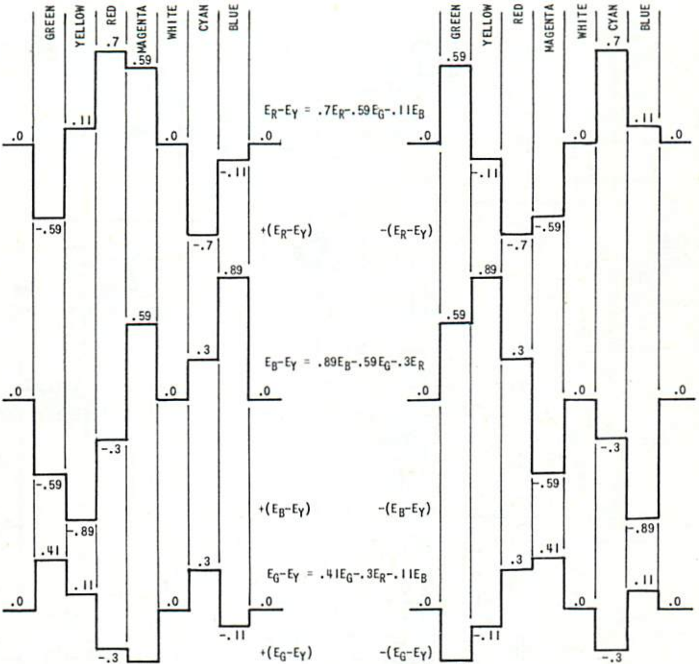


FIGURE 13

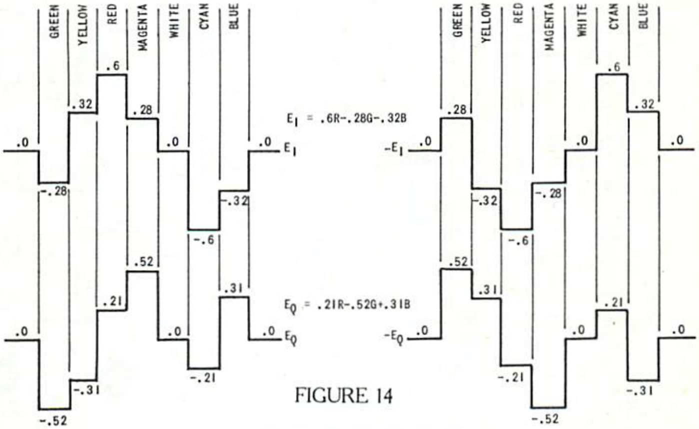


FIGURE 14

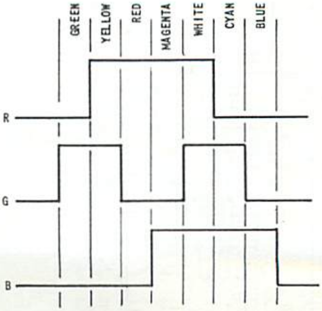


FIGURE 15

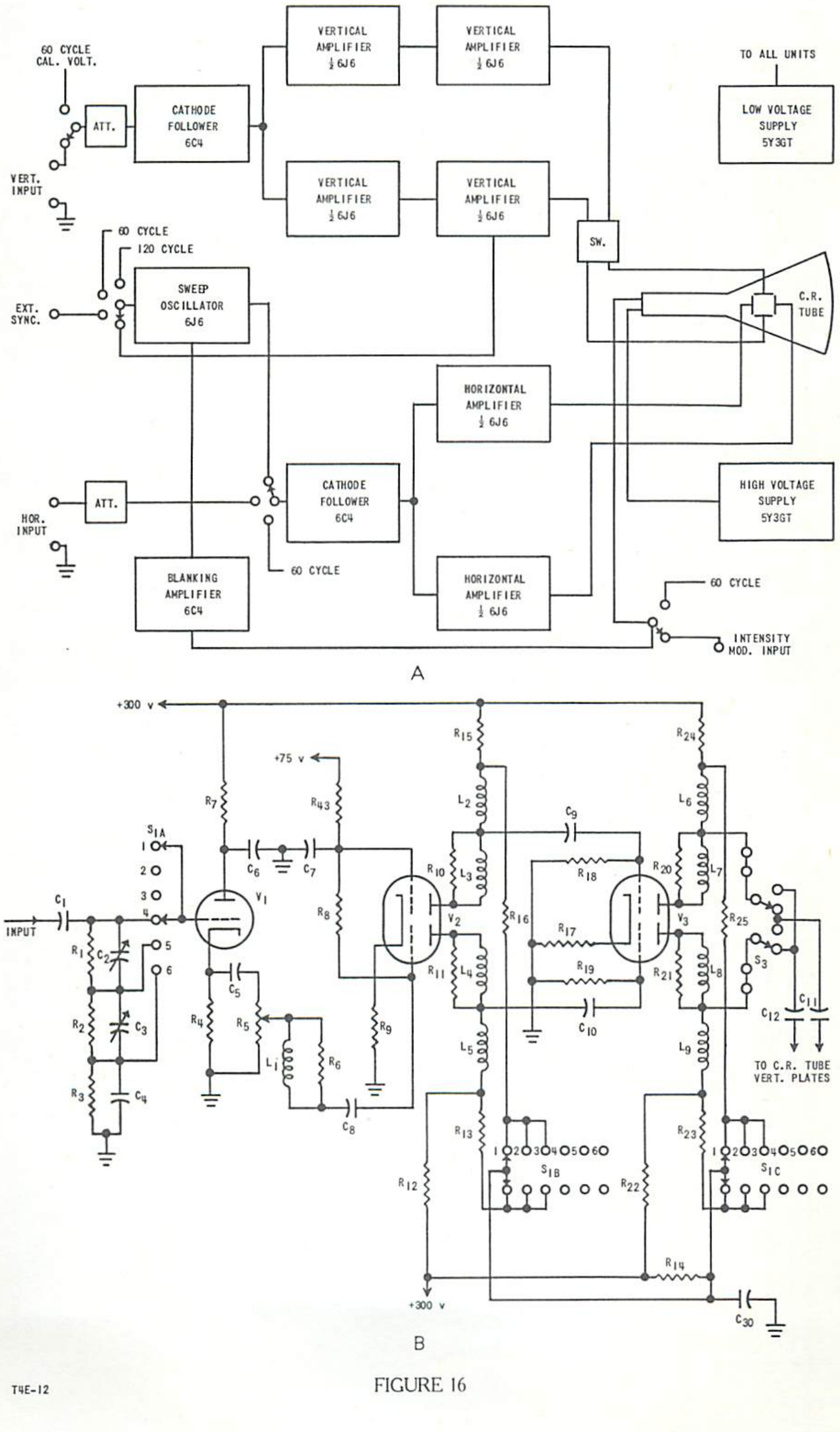

60 CYCLE CAL. VOLT.
ATT.
CATHODE FOLLOWER 6C4
VERT. INPUT
VERTICAL AMPLIFIER ½ 6J6
VERTICAL AMPLIFIER ½ 6J6
VERTICAL AMPLIFIER ½ 6J6
VERTICAL AMPLIFIER ½ 6J6
TO ALL UNITS
LOW VOLTAGE SUPPLY 5Y3GT
60 CYCLE
120 CYCLE
EXT. SYNC.
SWEEP OSCILLATOR 6J6
SW.
C.R. TUBE
HORIZONTAL AMPLIFIER ½ 6J6
HOR. INPUT
ATT.
CATHODE FOLLOWER 6C4
HIGH VOLTAGE SUPPLY 5Y3GT
60 CYCLE
BLANKING AMPLIFIER 6C4
HORIZONTAL AMPLIFIER ½ 6J6
60 CYCLE
INTENSITY MOD. INPUT
A
+300 v
+75 v
INPUT
C1
R1
C2
R2
C3
R3
C4
S1A
1
2
3
4
5
6
R7
V1
C6
C7
R43
R8
C5
R4
R5
L1
R6
C8
R9
V2
R15
L2
R10
L3
R11
L4
L5
R16
R13
R12
C9
R18
R17
R19
C10
V3
R24
L6
R20
L7
R21
L8
L9
R25
S3
C12
C11
TO C.R. TUBE VERT. PLATES
R23
R22
S1B
S1C
1 2 3 4 5 6
R14
+300 v
C30
B

FIGURE 16

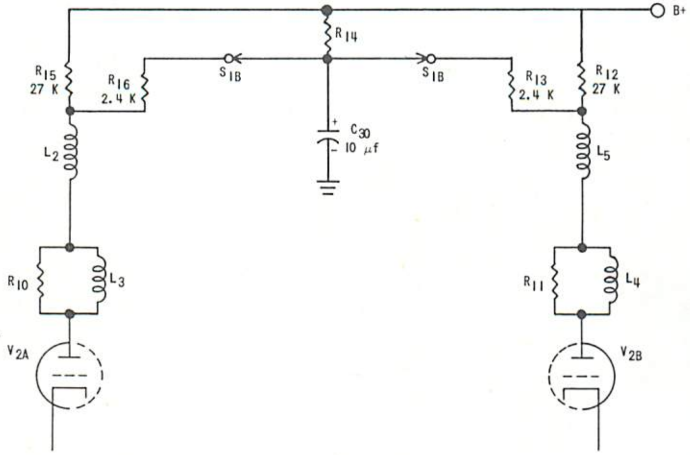


FIGURE 17

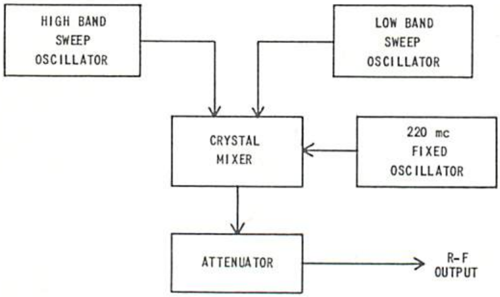


FIGURE 18

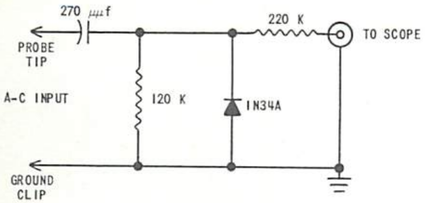


FIGURE 19

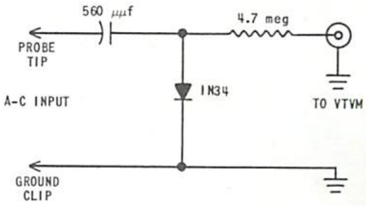


FIGURE 20

FROM OUR *Director's* NOTEBOOK

IS BUSINESS SELFISH?

When you buy furniture, a car, food, or ANYTHING, you want your money's worth, don't you? So does an employer.

He wants a man who can offer the most for the salary he offers. He wants a man who will help him make a profit for the business. It's the very basis on which all business is conducted. If you don't make a profit, you don't stay in business very long.

When you are first hired, your employer will lose money on you. Later, as you progress, he'll break even. Finally, your efforts will begin to pay him a profit, and as you earn more you'll be expected to make more profit for the company.

So as you go after the "gold in them thar hills," don't expect to get it all out with a single blast. Start as high as your training and experience warrant, but remember that business is just selfish enough to want you to prove you're worth. You would feel the same way if you were the employer.

Yours for success,

W. C. DeVry

DIRECTOR

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